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Design And Analysis Of A Spring Back Effect In Sheet Metal Forming

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Abstract:

One of the largest challenges in manufacturing is the consistency of final products. Two basic approaches have been investigated to achieve this goal. One is to use intelligent assembly methodologies to select a suitable set of parts to be assembled which is taking advantage of tolerance stack up. The other approach aims at each individual manufacturing process module, for example sheet metal forming process. The forming of sheet metal into a desired and functional shape is a process, which requires an understanding of materials, mechanics, and manufacturing principles. The major problem in fabrication of sheet metal parts is spring back effect i.e. the elastic strain recovery in the material after the tooling is removed. Spring back control is one of the key concerns of the sheet metal forming industry. The current trial-and-error method of testing and controlling for spring back is costly, time consuming, and remains as an obstacle in achieving shorter design production cycles. The elastic spring back at the end of a bending process plays an important role in determining the quality of final product thus in practice the constitutive relation that considers the elastic and plastic parts together has to be used. The factors have a non-linear interaction with each other so it is extremely difficult to develop an analytical model for spring back control including all these factors. So approach with FEA simulations are used to confront this difficulty.

Keywords: Spring back, design, strain, process and etc.,

Introduction

Sheet metal forming processes are those in which force is applied to a piece of sheet metal to modify its geometry rather than remove any material. The applied force stresses the metal beyond its yield strength, causing the material to plastically deform, but not to fail. By doing so, the sheet can be bent or stretched into a variety of complex shapes. A die with a long rail form tool that has concave or V shaped lengthwise channel that locates the outside profile of the form is called a die. Dies are usually stationary and located under the material on the bed of the machine[1]. The punch forms the bend so that the distance between the punch and the side wall of the V is greater than the material thickness (T).Either a V-shaped or square opening may be used in the bottom die. A set of top and bottom dies are made for each product or part produced on the press. Different materials and thicknesses can be bent in varying bend angles, adding the advantage of flexibility to air bending. There are also fewer tool changes, thus, higher productivity[2]. The bend beam can move the sheet up or down, permitting the fabricating of parts with positive and negative bend angles. The resulting bend angle is influenced by the folding angle of the beam, tool geometry, and material properties[3]. Bending is a metal forming process in which a force is applied to a piece of sheet metal, causing it to bend at an angle and form the desired shape. A bending operation causes deformation along one axis, but a sequence of several different operations can be performed to create a complex part[4]. The bend allowance (BA) is the length of the arc of the neutral line between the tangent points of a bend in any material. Adding the length of each flange taken between the center of the radius to the BA gives the Flat Pattern length[5]. The bend deduction (BD) is twice the outside setback minus the bend allowance. Most sheet metal drawings use this kind of dimensioning because it is offers more precise control over the flange lengths (compared to dimensioning it to the outside tangent of the radius) by removing any variations in the formed radius from the measurement[6,7]. Each of these approaches requires an understanding of the causes of spring back and the factors which affect its magnitude. With this knowledge, trial and error attempts at spring back correction become more effective[8,12].

Today many forming processes are carried out without a previous or accompanied finite element analysis of course. However, if the material flow or the loads of the rolling devices have to be investigated exactly, the numerical simulation is a must, if one does not want to invest too much money and time in practical experiments[9,10]. Static analysis is used to determine the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. Steady loading and response conditions are assumed; that is, the loads and the structure's response are assumed to vary slowly with respect to time[11,13].

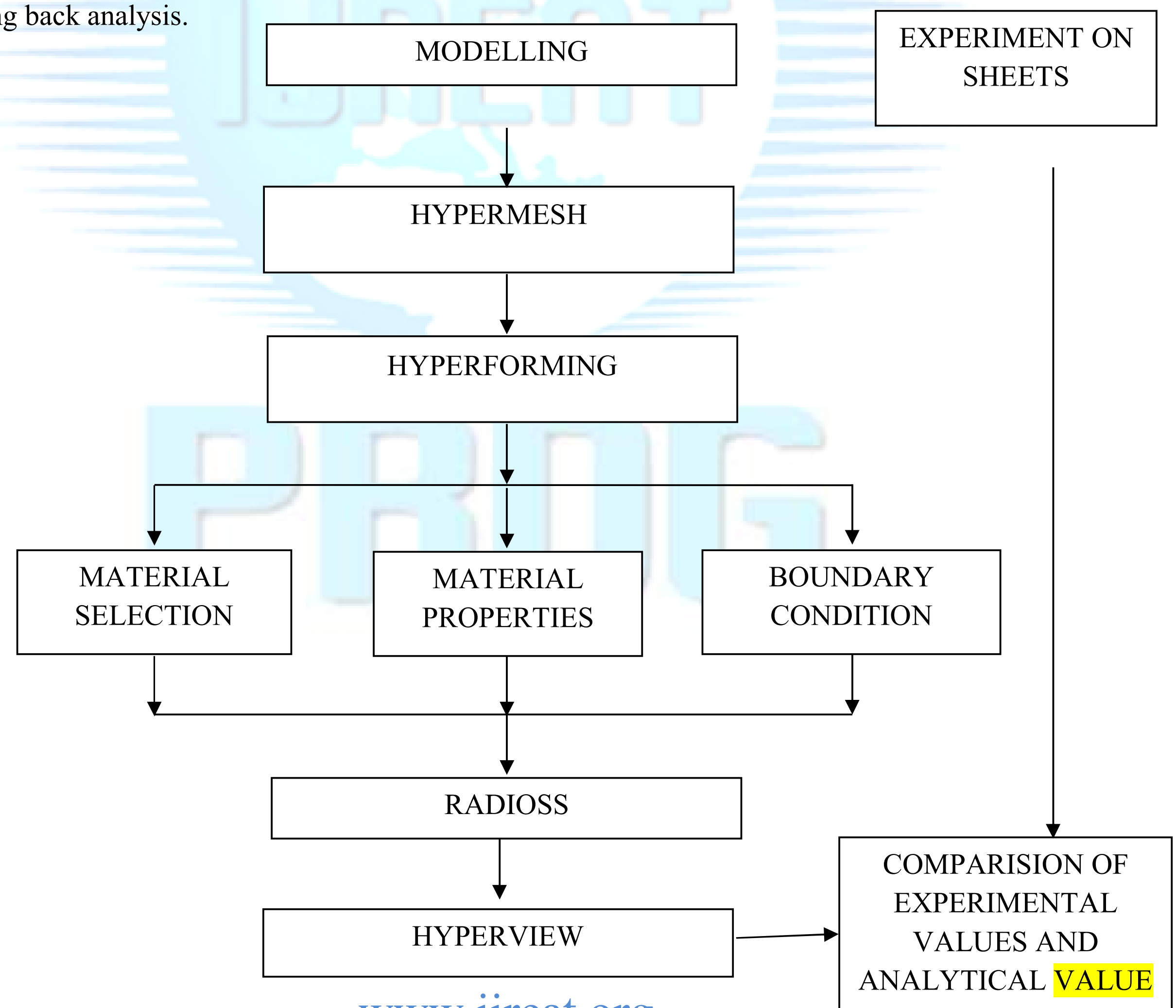
Materials and Methodology

Steel and aluminium are the two material which we used for this simulation. This two materials having different material properties. That material properties are given in the below table 1.

Table 1 Material Properties

Properties	**Steel**	**Aluminium**
Young's modules(E)	207 GPa	70GPa
Yield strength(Y)	205MPa	165MPa
Poisson ratio(µ)	0.3	0.33
Strain hardening exponent(n)	0.134	0.0987
Strength co-efficient (k)	525MPa	410MPa

These two materials having spring back effect also. So the below steps to be followed in this spring back analysis.



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The elastic springback at the end of a bending process plays an important role in determining the quality of final product thus in practice the constitutive relation that considers the elastic and plastic parts together has to be used. The factors have a non-linear interaction with each other so it is extremely difficult to develop an analytical model for springback control including all these factors. So approach with FEA simulations are used to confront this difficulty.

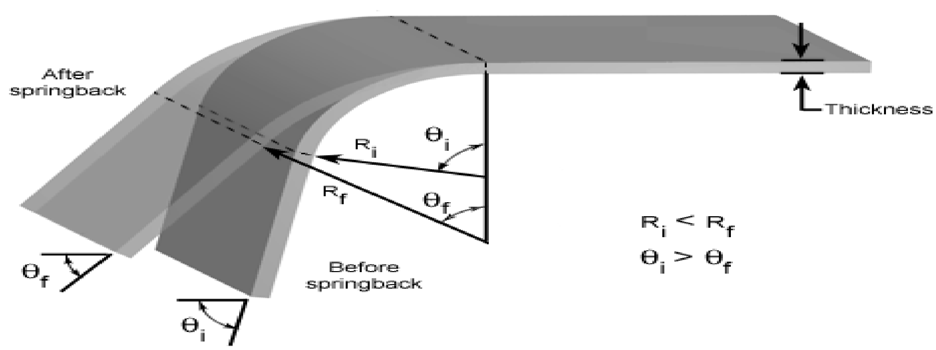

Figure 1 3D view of Spring Back Effect

Experimental Results and Discussion:

The below results are obtained from this analysis.In hyperforming and hyperviewing impact of stress deformation, percent thinning, relative angle for steel and aluminium were found as follows.

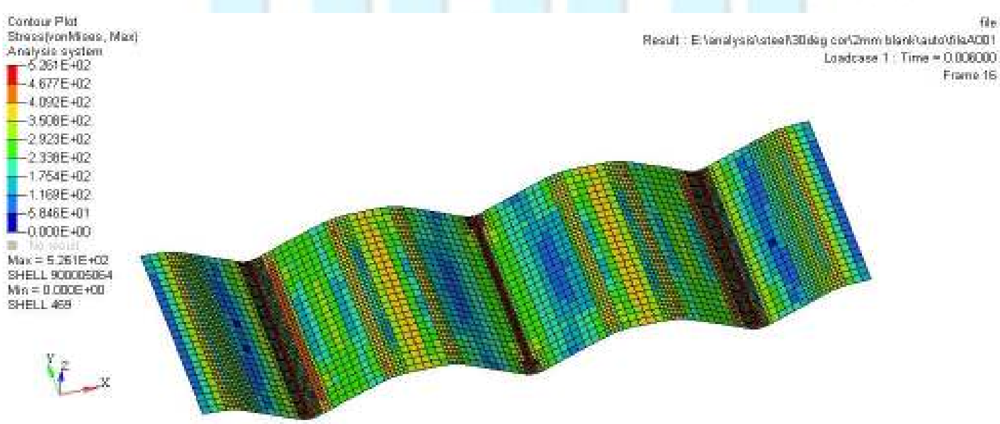

Figure 2 Impact Of Stress Deformation Of Steel

The impact of stress Deformation of steel is shown in the above figure 2. Stress plays a vital role in the deformation of steel.

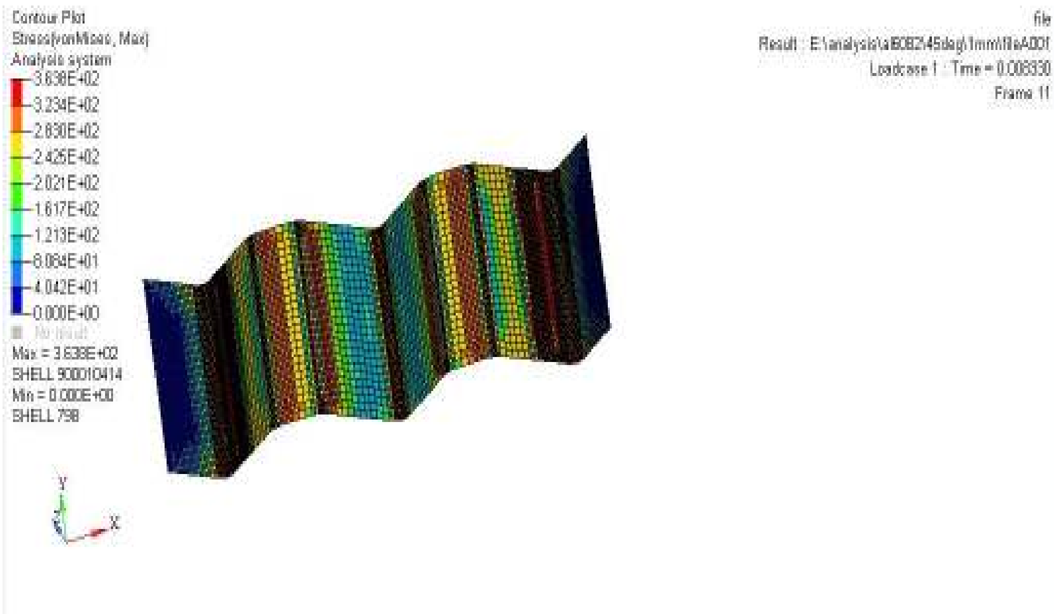

Figure 3 Impact Of Stress Deformation Of Aluminium

According to analysis results the impact of stress deformation of aluminium is shown in figure 3. It is the 3D view of aluminium sheet.

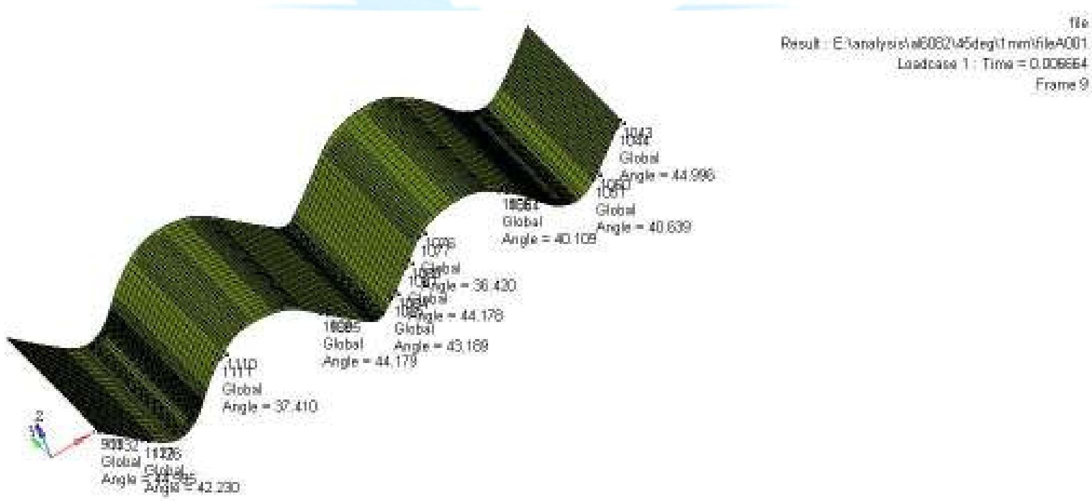

Figure 4 Relative Angle Of Aluminium

The above Figure 4 gives the perfect description about global angle of both materials steel and aluminium in this analysis

CONCLUSION

In the die 45^{O} bend angle the percentage of error varying from 2.5% to 13.5%. The thickness of the sheet decreases the percentage of error increases. Springback effect in corrugated bending varied with varying thickness of the sheet material. Springback highly depends on material properties (Yield stress, Young's modulus, and Strain hardening) and geometric parameters (thickness of sheet, die radius, sector angle) at minimal load condition and it decreases with increase in compression depth. The springback increases with increase in yield stress, strain hardening but it decreases with increase in Young's modulus. The binders can be used to reduce springback effect and also helps to distribute the stress evenly. The springback value decreased with the increasing thickness or decreasing the bending angle.

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